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Determining the habitat use of Varecia variegata in Maromizaha Protected Area, Madagascar

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Abstract

Understanding the interaction between frugivores and their habitat is necessary for both primate and forest preservation. In Madagascar, *Varecia variegata,* are the most highly frugivorous lemur in the Lemuridae family This project examined the habitat use of a troop of *V. variegata* (the black and white ruffed lemur) in Maromizaha, a newly protected area just outside of the village, Anevoka, in Madagascar. The hypothesis tested is that the size, location, flowering status, and species identity of trees selected by lemurs for particular activities (feeding, resting, sleeping) differ from the distribution of trees in the forest as a whole. There is evidence that *V. variegata* selected trees with significantly different CBH ($F_{1,733}$=24.8, p= 7.956e-07), height ($F_{1,733}$=20.64, p= 6.488e-06), and phenology compared to the general habitat observed in the identified territory.

Intro

Deforestation is one of the major threats to primate populations, along with bushmeat hunting, disease, and climate change (Chapman, Lawes, & Eeley, 2006). A study of three tropical rainforests in East Africa found that local forest disturbance led to a decline in the forests' frugivorous species (Kirika, Farwig, & Böhning-Gaese, 2008). Not all species are equally vulnerable to the effects of forest disturbance, and primates with low ecological flexibility are more susceptible to disturbance than those with broader ecological niches (Chapman et al., 2006).

The majority of African primates tend to occur across relatively small geographical ranges, in relatively small blocks of forest, with the exception of primates in the Congo Basin (Eeley & Lawes, 1999; Cowlishaw & Dunbar, 2000). Maintaining viable populations of trees species that serve as food sources is a crucial factor for primate conservation (Mwavu & Witkowski, 2009). In a study by Kirika et al. [2008], on forest disturbance, it was observed that fruit preference among primates may be defined by differences in crop size, fruiting phenology, morphology or chemical composition. As fruit availability in the surrounding forest increased, trees with potentially unattractive fruits experienced less frugivore visitations (Kirika et al., 2008). This may have been due to increased competition among frugivore species and fruit tree preference by the species (Kirika et al., 2008).

For the black and white ruffed lemur (*Varecia variegata*), found only in Madagascar, food availability is linked to phenology, abundance, and morphology of the forest tree species (Balko & Underwood, 2005). Madagascar is the only place in the world where lemurs are indigenous. According to the IUCN, there are about 104 different lemur species and *Varecia variegata,* the black and white ruffed lemur, has been listed as Critically Endangered (CR) by the

IUCN since 2008 (Andrainarivo et al., 2008). It is threatened by habitat loss and fragmentation due to anthropogenic and natural causes. Natural disasters and human disturbances can be sources of stress for this species and force them to utilize the fruit from tree species that are not preferred and to expend energy foraging and feeding on flowers, young leaves, or fungi rather than fruit (Ratsimbazafy, 1995).

During key life-history events such as reproduction, mating, and gestation, *V. variegata* utilizes different fruit species in their habitats (Balko & Underwood, 2005). Seasonally, the number of feeding bouts, but not the duration of feeding, is greater during the wet season (January-April) compared to the dry season (May-July) (Adam Britt, 1996). *V. variegata* tend to use the larger and taller trees in their territory compared to the general profile of the forest (White, 1995). A large diameter at breast height (DBH) usually suggests greater growth potential for an individual tree. However, most of the food trees *V. variegata* were using at three sites in the Ranomafana National Park had a diameter-at-breast-height (DBH) less than 50cm (Balko & Underwood, 2005).

V. variegata serve an important ecological role as seed dispersers in their habitats (Britt, 2000). Primate seed dispersers are important in their habitats because many tree species in their forest habitats have fruits and seeds that are specifically adapted for dispersal by vertebrates (Jordano, 1992). A decrease or loss of primate species from a forest results in less seed dispersal which leads to a loss of genetic diversity and a change in forest composition (Asquith, Terborgh, Arnold, & Riveros, 1999; Wang, Sork, Leong, & Smith, 2007). *V. varietata* often consumes whole seeds which are later passed as feces, various distances from the source tree (Adam Britt, 2000). A decrease in *V. variegata* from their natural habitats could be detrimental to the already threatened forest landscapes in Madagascar.

This project examined the habitat use of a troop of *V. variegata* in Maromizaha PA (Protected Area), a newly protected area just outside of the village, Anevoka, in Madagascar. No previous research has been conducted on the *V. variegata* within the protected area nor has it been determined if they have been affected by the previous human activities within the forest.

The first task was to identify the range of area the group was using in Maromizaha Protected Area (PA). The second was to compare the measured features of the forest habitat utilized by Group 1 to the general habitat within the territory to determine if there is a significant difference. The hypothesis tested is that the size, location, flowering status, and species identity of trees selected by lemurs for particular activities (feeding, resting, sleeping) differ from the distribution of trees in the forest as a whole. The null hypothesis is that lemurs select trees randomly for these different activities.

Understanding the habitat use of *V. variegata* here can serve as a baseline for research in the protected area and contribute to future studies on the same troop and as a comparison to other study sites in Madagascar. The home range data can supplement the PA's database and can be used for comparison with other species. It is important that the tree species utilized by Group 1 (particularly *C. madagascariense* and *Chassilia ternifolia* (**Table 4**)) continue to be monitored since the troop seemed to rely on them the most.

Methods

<u>Species Natural History</u>

Varecia variegata, are the most highly frugivorous lemur in the Lemuridae family; the percentage of fruit in the *V. variegata* diet exceeds the percentage of other food items such as leaves, fungi, or flowers (Adam Britt, 2000; Ratsimbazafy, 1995). Concentrations of fats and unstructured carbohydrates in the fruits of species consumed by *Varecia* were more than double what was found in consumed leaf species, but leaves contained higher concentrations of fiber than did fruits (Schmidt et al., 2010). A distinctive characteristic of *V. variegata* is its short digestion period (Adam Britt, 2000). Due to the fast retention and passage rates of gut contents, *Varecia variegata* is not able to effectively and efficiently convert fiber into energy (Ratsimbazafy, 1995). Therefore, *V. variegata* is more dependent on fat and unstructured carbohydrates from fruit for energy than fiber fermentation (Schmidt et al., 2010).

The black and white ruffed lemur is found specifically within lowland and mid-altitude (1,300 meters above sea-level) gneiss rainforest patches with minimal human impact which extends from Mantadia National Park to the southern edge of Mananjary (***Figure 1)*** (Dumetz, 1999; Mittermeier et al., 2010; Ratsimbazafy, 1995). A recent study reported the discovery of *Varecia variegata* in two new areas within the southern range: Ambalavero and Vohitrambo, (Rakotonirina et al., 2013). They have also been seen in the protected forest of Maromizaha in central-eastern Madagascar (Gamba et al., 2001).

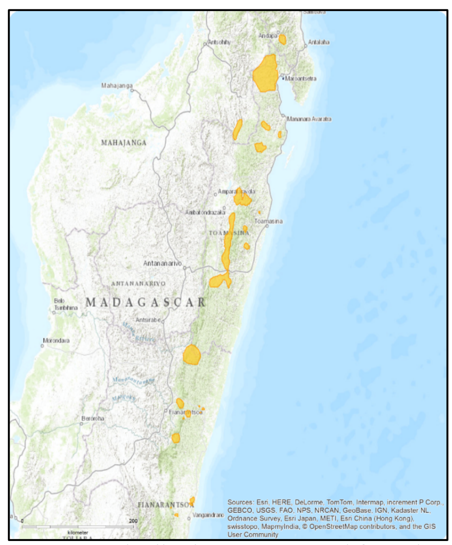

Figure 1: Distribution map sourced from the IUCN Red List Assessment (Andrainarivo et al., 2008). The yellow polygons represent areas were the *V. variegata* range extends. Maromizaha is within the area directly east of Antananarivo, located at the eastern-center of Madagascar.

<u>Study Area</u>

Maromizaha PA is located just 150m east of Antananarivo by Route Nationale 2. Until 2001, the forest was used unsustainably for activities such as logging and agriculture. Now agricultural dependence is limited, deforestation was stopped, and 1,600ha of the forest were preserved by the Groupe d'Etude et de Recherche sur les Primates de Madagascar (GERP), (Gamba et al., 2001). The protection plan was not only for the benefit of the forest, but also for the neighboring village, where it promoted development, education and positive social attitudes towards the protected area (Gamba et al., 2001).

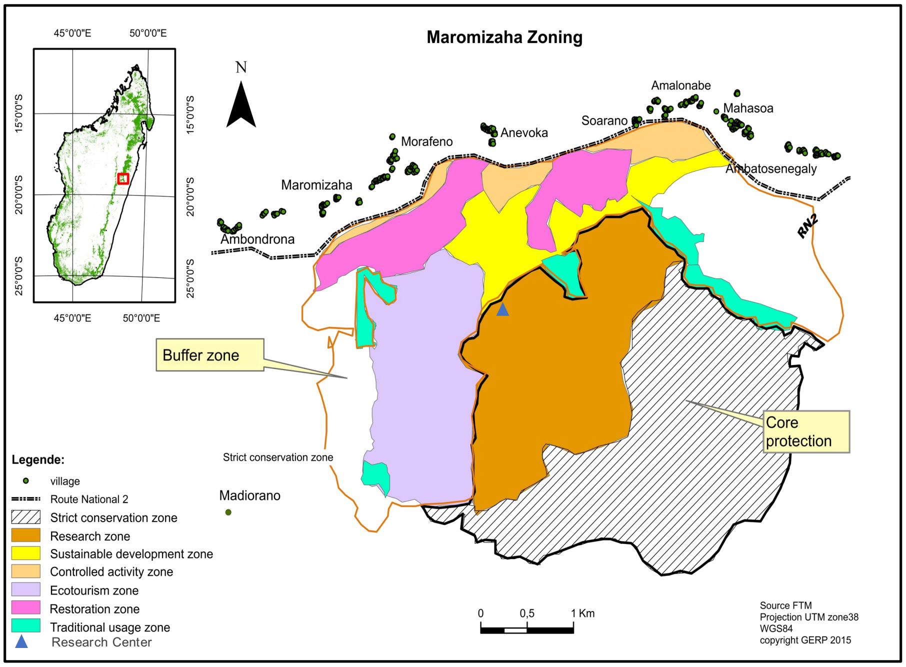

Figure 2: This map shows the zoning of Maromizaha based on the level of protection for each area

For management, the forest was divided into two main area types: the buffer zone, where villagers are able to sustainably use the land to farm, harvest trees for charcoal, and support ecotourism, and the core, which is mostly a protected nature reserve with a small area reserved for research (***Figure 2***) (Gamba et al., 2001). These factors, in addition the established research center in the research zone, rendered Maromizaha forest was a good location for the project.

Data Collection

GERP permitted me to do the research in the protected area and helped to establish a connection with a guide from Anevoka, Mamy, who specialized on *Varecia variegata*. Mamy served as an important resource for tree species identification and locating the *V. variegata* troop during this study. We were joined by Freddie, a guide in training, who assisted in taking measurements and tree identification. I studied one troop (Group 1) of *Varecia variegata* in the protected area of Madagascar, Maromizaha from April 2, 2016 through April 17, 2016. Team communication was predominantly in French and Malagasy (the native language of Madagascar). I led this research team of three for the duration of this project and all data collected and observations made were carried out during this study.

In total, there were approximately 96.22 hours of field work: 11.25h of re-habituation for Group 1 *V.* variegata, 49.15h of *V. variegata* habitat use observations, about 18h measuring tree characteristics for trees used by the troop, and 18h measuring trees along transects. Around 760 trees were measured for characteristics of height, circumference, species and phenology. The observations and data collected during the re-habituation period were not used in analysis. It can be noted that these data were collected during the wet season, and will be compared with data collected during the same season.

<u>*V. variegata* habitat use</u>

There were two identified troops of *V. variegata* within the protected area. For the focus of this study, four individuals identified as Group 1 were followed. They were studied using group follows. No individuals were collared or tagged, but were identified by a local guide, Mamy, who could identify individuals and locate the group for each day of observation. The moment one individual of Group 1 was found, habitat use observations began. When the group would rapidly disperse, and visibility of the group was lost, the first individual re-spotted was the new focal individual.

Trees that were used for sleep, rest, feeding, and drinking were marked and the Global Positioning System (GPS) location of the tree was recorded. The GPS record, the height of the lemur in the tree, its activity, and the time were noted.

Sleep was identified when the lemur was on a branch on its stomach, and curled up, head resting between its front paws (***Figure 3***). Resting was identified when a lemur was on a branch without movement for at least 1 minute (***Figure 3***). When a lemur consumed fruit, leaves, or flowers from a tree, it was identifies as feeding (***Figure 3***). Drinking was identified when a lemur was seen taking water from a tree cavity with its paws or mouth, or when a lemur was seen drinking from pools of water that collected in the leaves.

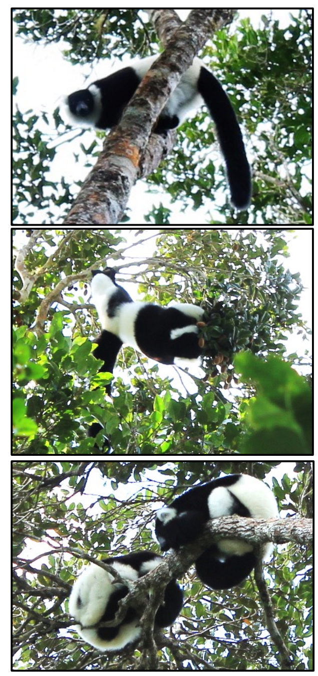

Figure 3 From top to bottom, these photos depict the Group 1 lemur activities: rest, eat, and sleep.

On days that the lemurs were not followed, the previously identified trees were returned to and the point-center-quarter method (PCQ) was applied (Mitchell, 2010). This method was ideal for this study because it requires less people and is more effective and efficient than a plot-based method (Mitchel 2010). The tree the lemur utilized was the center tree, and 4 quadrants were created using cardinal directions on a compass. In each quadrant, the distance to the nearest tree from the center tree (with a circumference at breast height (CBH) greater than 10 cm) was measured. For the center tree and each of the 4 quadrant trees, the species was identified, the total height was visually estimated, the presence of leaves, fruit, or flowers was noted, and circumference at breast height (CBH) was measured using a meter tape. Species identification was done with the help of a local guide, Mamy, who used the vernacular names. With a document provided by the protected area's management, *Appendix II*, the names were later converted to their scientific form.

Measurements of forest habitat structure within Group 1 territory

Five, west-to-east transects were established within an estimate of the Group 1 territory. Transect length varied depending on the distance between the boundaries of the territory (refer to **Figure 5**). Individual transects were approximately 80 meters apart. Sample points along the transects were selected using three randomly generated values. First, each consecutive distance along the transect was generated as a number between 1m and 30m. A greater range would not allow for enough sampling points along the transect. Second, the direction to travel off the transect was generated (Right or Left). Third, the distance from the transect in the determined direction was generated as a value between 1m and 40m. This range was selected because 40m was half of the distance between each transect. Each distance was measured using the GPS tracker tool. The same PCQ method as in *Varecia* measurements was used and the first tree that was closest to the randomly selected coordinate became the center tree (Mitchell, 2010). The same characteristics were measured (total height, presence of leaves, fruit, or flowers, and CBH).

Statistical analysis

The statistical software program R (Version 0.99.902 – © 2009-2016 RStudio, Inc.) was used to analyze these data sets. The large quantity of data was reorganized and converted to make it compatible for R to read. The analysis code can be found in *Appendix I*. The unit of observation was an individual tree, and the response variable used the tree type as a predictor (lemur tree or random tree). The null hypothesis was that there is no consistent difference in the characteristic of trees used by lemurs compared to randomly selected trees in the forest.

Area Map

From the GPS data collected during *V. variegata* observations, and the randomly sampled data observations, the points were compiled and entered into Google Earth Pro. A polygon was added to boarder the group of points to outline the observed territory. The total area of the territory was calculated using Google Earth Pro features. Lemur density was calculated as a fraction of the number of Varecia in Group 1 divided by the total calculated area of the habitat.

Results

Area Map

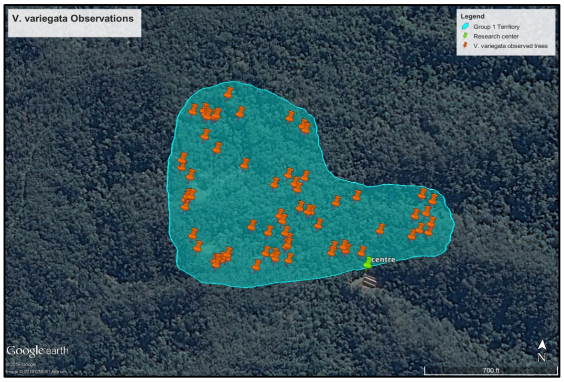

Figure 4 This map shows the estimated territory used by Group 1 *V. variegata* in Maromizaha Protected Area. Each marker is an observation point for habitat use.

Figure 5 This map displays the transects and randomly sampled trees within the estimated Group 1 V. variegata territory.

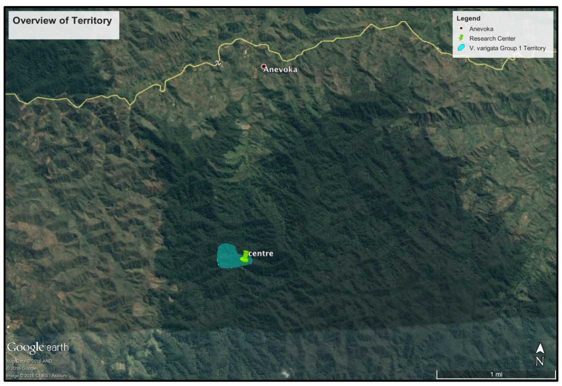

Figure 6 This map presents the territory in relation to Route Nationale 2 (yellow line) and the nearest village, Anevoka.

The approximate perimeter of the range used by *V. variegata* is 1,456.65m and the area of the Group 1 territory use is 11.2ha with a density of is 0.357 *V. variegata*/ha. Each tree that was considered used by Group 1, is shown in **Figure 4.** **Figure 5** presents the randomly sampled trees located along transects. **Figure 6** is an overview of the study area and the estimated territory.

Ecological Characteristics

The mean CBH for trees used by *V. variegata* Group 1 is 56.1cm, the maximum is 3.56m, and the minimum is 12cm. Among the randomly sampled trees, the mean is 38.7cm, the maximum is 2.3m, and the minimum is 11cm. The trees used by Group 1 are significantly larger ($F_{1,733}$=24.8, p= 7.956e-07) in circumference (CBH) than the randomly sampled trees (**Figure 8**).

The mean height for trees used by *V. variegata* is 13.61m, the maximum is 28m and the minimum is 2m. The mean height for random samples within the territory is 11.98m, the maximum is 22m, and the minimum is 2m. There is a significant difference ($F_{1,733}$=20.64, p= 6.488e-06) between the height of trees used by Group 1 and those randomly sampled in the territory (**Figure 10**).

The forest density of the areas used by Group 1 is not significantly different ($F_{1,586}$=0.4504, p=0.5024) than the density of the territory overall (**Figure 12**).

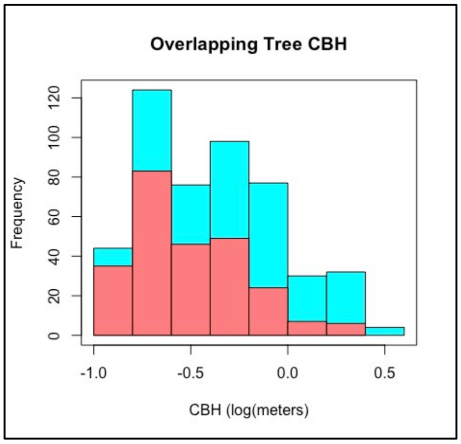

Figure 7 The Tree CBH histogram above shows the total circumference at breast height (CBH) data where blue represents the trees from the habitat utilized by Group 1 and red was the randomly sampled trees.

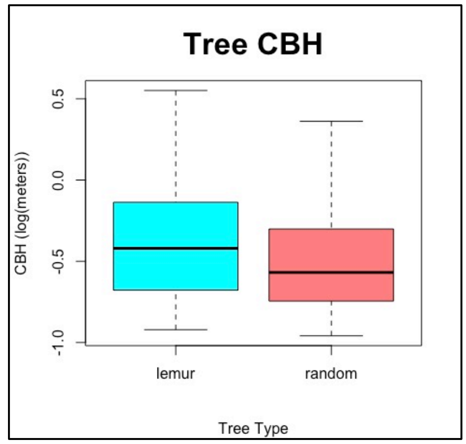

Figure 8 The Tree CBH box plot shows the relationship between the circumference of trees used by *V. variegata* (blue) vs. the randomly sampled trees in the Group 1 territory (red). There was a significant difference observed $F_{1,733}$=24.8, p= 7.956e-07.

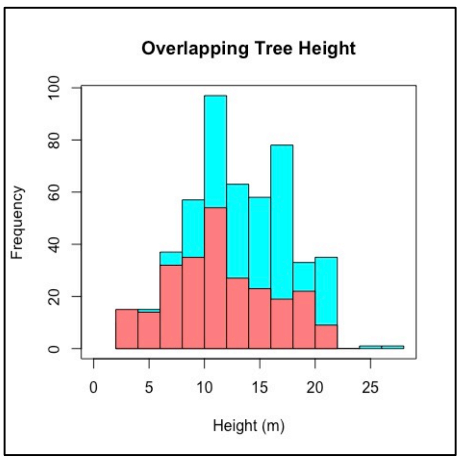

Figure 9 The Tree Height histogram shows the total tree height data where red is the randomly sampled tree data and blue is the habitat utilized by Group 1.

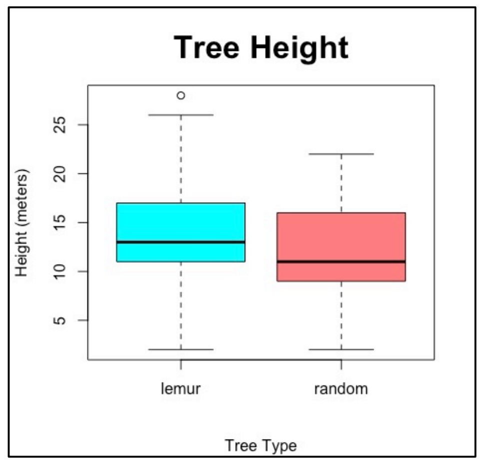

Figure 10 The Tree Height box plot compares the height of trees used by Group 1 and the height of random samples within the territory. There is a significant difference between the two groups: $F_{1,733}$=20.4, p= 7.316e-06

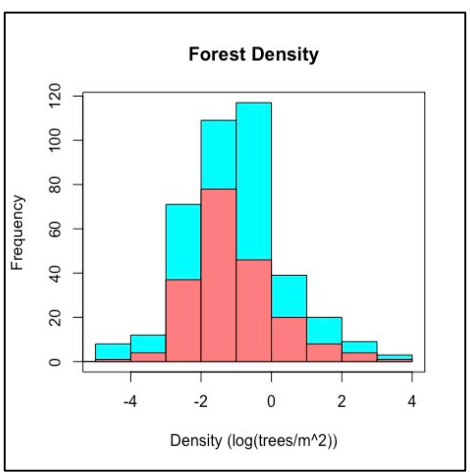

Figure 11 The Forest Density Histogram above shows the forest density of the habitat utilized by Group 1 (blue) and the randomly sampled data (red).

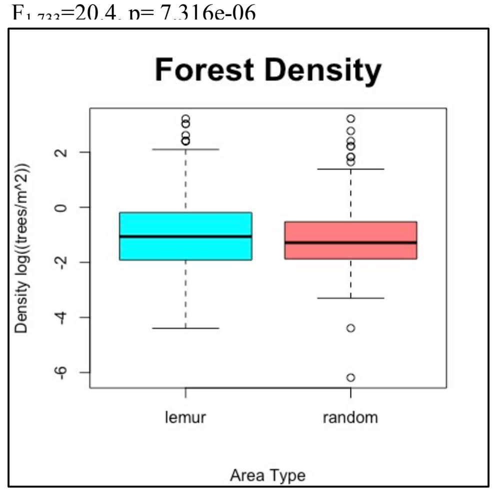

Figure 12 The Forest Density boxplot compares the forest density of the areas randomly sampled (red) and the areas utilized by Group 1 (blue). There was not a significant difference between the densities ($F_{1,586}$=0.4504, p=0.5024).

Table 1 The Percent of Tree Phenology Table shows the percentages of the types of phenology found in areas used by the *V. variegata* and those found in the randomly sampled areas in the overall territory.

Tree Phenology by Habitat Type		
Phenology	**Varecia %**	**Random %**
Fruit	12.16	4.8
Leaves	87.63	95.2
Flowers	0.21	0

Table 2 Most Frequent Species Table compares the seven most common species that occurred within the territory and that were used by Group 1 in Maromizaha Protected Area. There was a significant difference between the species found in areas used by *V. variegata* and those randomly sampled (X-squared = 14.84, df = 6, p-value = 0.0215)

Most Frequent Species		
Species	***V.variegata***	**Random**
Canarium madagascariense	19	0
Chassalia ternifolia	13	8
Cyathea borbonica	18	18
Eugenia lokohensis	15	6
Ocotea sp.	22	10
Protorhus ditimena	17	7
Schefflera vantsilana	14	7
X-squared = 14.84, df = 6, p-value = 0.02154		

Table 3 Most Frequent Species Table compares the seven most common species that occurred within the territory and that were used by Group 1 in Maromizaha Protected Area. There was not a significant difference between the species found in areas used by *V. variegata* and the randomly sampled areas (X-squared = 4.462, df = 5, p-value = 0.485)

Most Frequent Species without *C. madagascariense*		
Species	***V.variegata***	**Random**
Chassalia ternifolia	13	8
Cyathea borbonica	18	18
Eugenia lokohensis	15	6
Ocotea sp.	22	10
Protorhus ditimena	17	7
Schefflera vantsilana	14	7
X-squared = 4.462, df = 5, p-value = 0.485		

Table 4 The Percent Frequency of Species Used by *V. variegata* table lists the most commonly identified tree species that Group 1 was observed on in Maromizaha PA.

Percent Frequency of Species Used by *V. variegata*	
Species	**% Freq. Obs.**
Canarium madagascariense	17.5
Chassalia ternifolia	8.2
Eugenia bernieri	5.2
Eugenia lokohensis	6.2
Ficus sp.	5.2
Melanophylla sp.	4.1

In the territory utilized by Group 1, 12.16% of the trees were fruiting, 87.63% were only leaves, and 0.21% were flowering. In the general habitat, 4.8% of the trees were fruiting, 95.2% of the trees had only leaves, and 0% were flowering (**Table 1**).

The tree species that was most often found in areas used by Group 1 was *Octea sp*. observed 22 times, with 10 observations in the randomly sampled areas (***Table 1 & 2***). (***Table 1***). *Cyathea borbonica* was the most commonly observed species, 18 times, for the randomly sampled (***Table 1& 2)***. Including *C. madagascariense*, there was a significant difference between the species found in areas used by *V. variegata* and the randomly sampled areas (***Table 1***: X-squared = 14.84, df = 6, p-value = 0.0215). Without this species, there is not a significant different between the species in areas used by *V. variegata* and the randomly sampled areas (***Table 2***: X-squared = 4.462, df = 5, p-value = 0.485).

The most frequently used species by Group 1 was *Canarium madagascariense,* 17.5% of the trees utilized (**Table 4**). *Chassalia ternifolia* was the second most commonly used by *V. variegata* (**Table 4**).

On average, the lemurs occupied the top 81.9% of trees (***Figure 14***). Group 1 was most frequently observed between a height between 17m and 18m (***Figure13***).

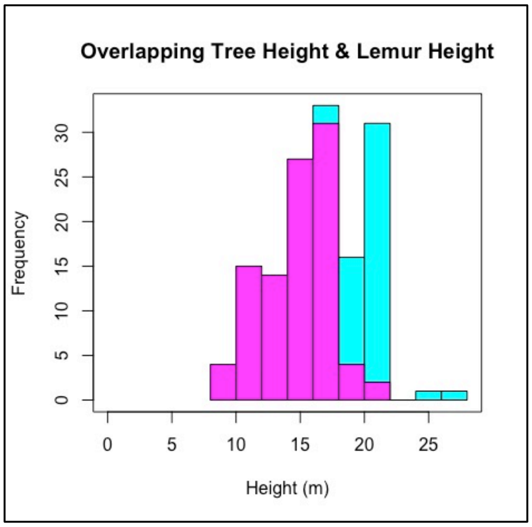

Figure 13 This figure represents the frequency of tree heights used by Group 1 (blue) and the frequency of the height of lemur individuals (purple).

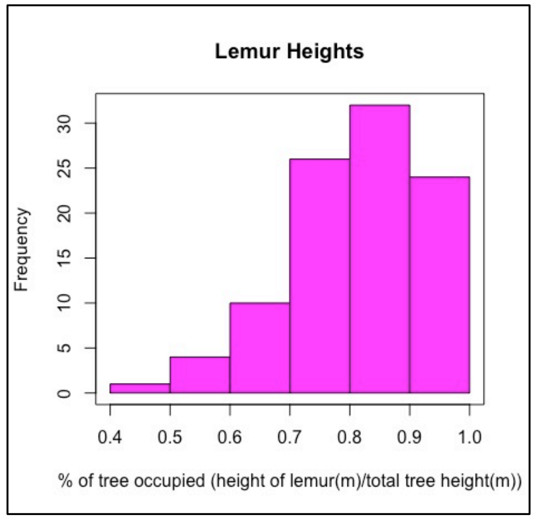

Figure 14 Lemur Height histogram represents the frequency of the percent of the tree height occupied by individuals of Group 1, on utilized trees. On average, the individuals occupied the top 81.9% of the tree.

Discussion

Varecia variegata serve an important ecological role in their habitats as seed dispersers, which are linked to forest composition and genetic diversity (Asquith et al., 1999; Adam Britt, 2000; Wang et al., 2007). As they have never previously been studied in Maromizaha PA, understanding their habitat use here can contribute to management planning and baseline data on their habitat use compared to other study areas. This study examines the habitat use and areas occupied by Group 1 *V. variegata* in Maromizaha PA. The null hypothesis tested that lemurs select trees randomly in their territory for particular activities (feeding, resting, sleeping).

In Ranomafana National Park, different troops of *V. variegata* were observed to have an average home range of 29.1±21.89ha which compares to the 11.2ha (**Figure 4**) range found in this study (Razafindratsima, Jones, & Dunham, 2014). Although these mean home ranges vary, this study only observed the troop's habitat range during April, at the end of the wet and cold season. It is possible that the area this troop used at this time in the season will differ from the year overall. *V. variegata* is governed by its highly spatio-temporally patchy diet, which is dependent on fruit availability and dispersion and reproductive biology (Balko & Underwood, 2005; Vasey, 2000). Furthermore, it has been observed that ecological similarities for habitat use (tree height, CBH, and phenology) are more consistent between troops, than social organization (home range and troop size) which varies among study sites (Vasey, 2000).

The Group 1 *V. variegata* habitat use of trees that are larger (CBH) and taller (**Figure 8 &10, Table 1)** than those in the overall habitat is consistent with observations form other studies (Balko & Underwood, 2005; White, Overdorff, Balko, & Wright, 1995). Furthermore, the high percentage of fruiting trees (**Table 1**) that were used by Group 1 is backed by previous research based on year-round observations that showed that the *Varecia* species spends 74–90% of their time feeding on fruit trees (Martinez & Razafindratsima, 2014).

Varecia are key seed dispersers in the forests they inhabit due to the high fruit diet and high percentage of seeds found in feces. It has been observed that 90% of fecal samples collected from the sub species *Varecia rubra* contained at least one seed from their consumption (Martinez & Razafindratsima, 2014). In Ranomafana NP, while there are some overlaps in fruit taxa eaten by lemurs, many were exclusively consumed by one lemur species, suggesting that certain seeds may depend on that one species for dispersal (Wright et al., 2011; Bollen, 2003).

The tree species *C. madagascariense* seems to be a particularly important food source for *V. variegata* not only in this study, but across study areas (A. Britt, 1998; Adam Britt, 2000; Razafindratsima et al., 2014; Schmidt et al., 2010; Wright et al., 2011). During this study period, Group 1 frequently visited to one individual *C. madagascariense* within their territory. While on this individual tree, the troop was observed feeding, resting, and sleeping. It is possible that spatial memory of fruit availability in the forest influenced the repeated visits. A study on two mangabey species in Taï National Park on the Ivory Coast used their memory and visual cues to identify and find fruiting trees (Janmaat, Byrne, & Zuberbuhler, 2006).

V. variegata is an obligate frugivore, dependent on fruit as a main food source throughout the seasons (Vasey, 2000). The availability of food for *V. variegata* in the form of mature and palatable fruit is tied to abundance, morphology and phenology of the forest tree species (Balko & Underwood, 2005). Madagascar rainforests produce flowers and fruit on irregular, prolonged, asynchronous or alternate year cycles that may further vary across one forest system (Wright et al., 2011). As previously mentioned, this study took place during the end of the cold and rainy season when fruit production was not yet at its peak, thus the troop may have been reliant on this individual due to the shortage of available fruit in the forest. The species shows high behavioral and demographic sensitivity to fruit availability, particularly during shortages that occur during the austral winter (Balko & Underwood, 2005). It is important to continue to study this troop during other times of the year because as fruit availability and distribution change, it is possible that the area occupied by the troop, and the tree species consumed will vary.

It is important for future management practices to reflect the results of this study that that tie together the relationship between a frugivorous primate and its habitat. Management interventions must consider capturing entire forest communities for frugivores because some tree species are specific to particular forest communities (Mwavu & Witkowski, 2009). One suggestion for timber and wildlife conservation would be to leave behind standing, mature, fruiting trees in logged areas as the fruit would provide food for frugivorous mammals who would contribute to seed dispersal (Mwavu & Witkowski, 2009). Incorporating a holistic approach that addresses preservation of the forest, its species and the interactions with the community is important to conservation efforts.

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Appendix I

```
#initial analysis of lemur data 1/13/16 RR
data <- read.table("lemur2016.csv",header=TRUE,sep=",",stringsAsFactors = FALSE)
str(data)
summary(data)
#initial cont. ->for categorical variables, use the table command
table(data$Type)
table(data$S)
#initial cont. ->for numeric variables, use hist command
hist(data$Latitude)
hist(data$Longitude)
hist(data$CBH)
hist(data$HT)
hist(data$LH)
# to get counts of discrete variables
table(data$Type)

# Analysis simple ANOVA to test for differences in a continuous variable between lemur and random trees.
str(data)

vec <- seq(0,4,by=0.2)
#BOX PLOT OF CBH/HEIGHT AND ANOVA
#CBH
data$Type <- as.factor(data$Type)
data$logCBH <- log10(data$CBH)
hist(data$CBH, main="Tree CBH", ylab="CBH (meters)", sub="Tree Type",cex.main=2 )

#need to take log b/c it was skewed
hist(data$logCBH[which(data$Type=="lemur")], col=rgb(0,1,1), main = "Overlapping Tree CBH", xlab ="CBH
(log(meters)")
hist(data$logCBH[which(data$Type=="random")], col=rgb(1,.5,.5), add=T)
box()

boxplot(data$logCBH~data$Type,main="Tree CBH",col=c(rgb(0,1,1), col=rgb(1,.5,.5)),
    ylab="CBH (log(meters))", sub="Tree Type",cex.main=2)
modelCBH <- lm(data$logCBH~data$Type)
summary(modelCBH)

mean(data$CBH[which(data$Type=="lemur")])
mean(data$CBH[which(data$Type=="random")])

max(data$CBH[which(data$Type=="lemur")])
max(data$CBH[which(data$Type=="random")])

min(data$CBH[which(data$Type=="lemur")])
min(data$CBH[which(data$Type=="random")])

#Height
data$Type <-as.factor(data$Type)
boxplot(data$HT~data$Type,main="Tree Height",col=c(rgb(0,1,1), col=rgb(1,.5,.5)),
```

```
    ylab="Height (meters)", sub="Tree Type",cex.main=2)

hist(data$HT[which(data$Type=="lemur")], col=rgb(0,1,1), xlim=c(0,28), main = "Overlapping Tree Height",
xlab="Height (m)", ylab = "Frequency")
hist(data$HT[which(data$Type=="random")], col=rgb(1,.5,.5), add=T)
box()

modelHT <- lm(data$HT~data$Type)
summary(modelHT)

mean(data$HT[which(data$Type=="lemur")])
mean(data$HT[which(data$Type=="random")])

max(data$HT[which(data$Type=="lemur")])
max(data$HT[which(data$Type=="random")])

min(data$HT[which(data$Type=="lemur")])
min(data$HT[which(data$Type=="random")])

#SOLVING FOR ABSOLUTE DENSITY
#want to solve for mean distance = r; then solve for 1/r^2 and this will result in absolute density

#separate distance data
densitydata=data[which(data$D!="NA"),]
str(densitydata)
barplot((sort(table(data$S))))
summary(densitydata)

#density of lemur area ; 388 observations
meanlemur <- (mean(densitydata$D[which(densitydata$Type=="lemur")]))
densitylemur <- 1/meanlemur^2

#density of general habitat ; 200 observations
meangen <- mean(densitydata$D[which(densitydata$Type=="random")])
densitygen <- 1/meangen^2

#comparing the two densities
densityModel <- lm((1/(densitydata$D^2))~densitydata$Type)
summary(densityModel)
hist(1/(densitydata$D^2), main="Forest Density", xlab = "Density (trees/m^2)")

#necessary to take the log
hist(log(1/(densitydata$D[which(densitydata$Type=="lemur")]^2)), col=rgb(0,1,1), main="Forest Density", xlab =
"Density (log(trees/m^2))")
hist(log(1/(densitydata$D[which(densitydata$Type=="random")]^2)), col=rgb(1,.5,.5), add=T)
box()

boxplot(log(1/(densitydata$D^2))~densitydata$Type, main="Forest Density", col=c(rgb(0,1,1), col=rgb(1,.5,.5)),
    ylab="Density log((trees/m^2))", sub="Area Type",cex.main=2)

#TREE PHENOLOGY DATA OUTPUTS
#counts number of trees of each phenology (flower, fruit, leaves) for random and lemur use

length(data$P[data$P=="FR" & data$Type=="lemur"])
length(data$P[data$P=="FR" & data$Type=="random"])

length(data$P[data$P=="L" & data$Type=="lemur"])
length(data$P[data$P=="L" & data$Type=="random"])

length(data$P[data$P=="FL" & data$Type=="lemur"])
length(data$P[data$P=="FL" & data$Type=="random"])

#SOLVING FOR PERCENT OF TREE LEMUR OCCUPIES
#separate lemur tree data
lemurcenter=data[which(data$LH!="NA"), ]
str(lemurcenter)
```

```
hist(lemurcenter$HT, col=rgb(0,1,1), xlim=c(0,28), main = "Overlapping Tree Height & Lemur Height", xlab="Height (m)", ylab = "Frequency")
hist(lemurcenter$LH, col=rgb(1,0,1), add=T)
box()

boxplot(lemurcenter$LH, main="Lemur Height on Tree", ylab= "lemur height (m)")

#this solves for the percent of the tree occupied by lemur for each tree
lemurcenter$occupyLH <- lemurcenter$LH / lemurcenter$HT
hist(lemurcenter$occupyLH, col=rgb(1,0,1), main = "Lemur Heights", xlab= "% of tree occupied (height of lemur(m)/total tree height(m))")
box()
mean(lemurcenter$occupyLH)

#FREQUNCY OF SPECIES
#just focus graphs on species that occurred >3 times ; frequency of trees used by lemurs to compare to literature
table(lemurcenter$S)

#frequency of species found in general
table(data$S[which(data$Type=="random")])
#create table of species and type
treetable <- table(data$S, data$Type)
#shrunk table to just counts which are 3 or greater
treetable2 <- treetable[which(rowSums(treetable)>3),]

#third column which is sum of total abundance of species
treetable3 <- cbind(treetable2,rowSums(treetable2))
sort(treetable3[,3], decreasing=TRUE)

#produces 7 most abundant tree species ; >17 so as to include C. madagascariense in analysis
treetable4 <- treetable2[which(rowSums(treetable2)>17),]
print(treetable4)
print(chisq.test(treetable4))

#excludes C. madagascariense so as to compare if this one tree ; skews the data
treetable5 <- treetable2[which(rowSums(treetable2)>20),]
print(treetable5)
print(chisq.test(treetable5))

#frequency of species in lemur habitat
table(data$S[which(data$Type=="lemur")])
```

Appendix II

Groupe d'Etude et de Recherche sur les Primates de Madagascar (G.E.R.P) Liste floristique globale de Maromizaha

FAMILLE	Nom scientifique	Nom vernaculaire	Origine	Auteur
ACANTHACEAE	*Asystasia coromandeliane*	Belohalika		Nees
ACANTHACEAE	*Asystasia* sp1			Blume
ACANTHACEAE	*Asystasia* sp2	Beloalika		
ACANTHACEAE	*Hypoestes maculosa*	Velatra (Belohalika)	Trop	Ness
ACANTHACEAE	*Hypoestes* sp1		Trop	
ACANTHACEAE	*Hypoestes* sp2	Tsiañananana	Trop	
ANACARDIACEAE	*Micronychia tsiramiramy*	Vintanona madini-dravina	End	H. Perrier
ANACARDIACEAE	*Protorhus ditimena*	Ditimena	End	H. Perrier
ANACARDIACEAE	*Protorhus ditimena* var.1	Ditimena	End	
ANACARDIACEAE	*Protorhus latifolia*	Ditimena bory ravina	End	Engl.
ANACARDIACEAE	*Protorhus sericea*	Ditimena manitra be ravina	End	Engl.
ANACARDIACEAE	*Protorhus* sp1	Ditimena madini-dravina		
ANACARDIACEAE	*Protorhus thouvenotii*	Menavahatra	End	Lecomte
ANACARDIACEAE	*Rhus taratana*	Tarantana	End	(Baker) H. Perrier
ANACARDIACEAE	*Rhus thouarsii*		End	(Engl.) H. Perrier
ANNONACEAE	*Monanthotaxis* sp			Baill.
ANNONACEAE	*Popowia gerardii*	Ambavy fotsy	End	Baill. Ghesquiere
ANNONACEAE	*Uvaria acuminata*	Mandravasarotra, Sakarivohazo, Senasena,		Oliver
ANNONACEAE	*Xylopia emarginata*		End	Mart.
ANNONACEAE	*Xylopia flexuosa*	Hazoambo	End	Diels
ANONACEAE	*Polyalthia ghesquieriana*	Hazoambondrasaraka	End	Cavaco & Keraudren
ANONACEAE	*Polyalthia richardiana*	Ambavy	End	Baill.
ANONACEAE	*Xylopia lemurica*	Hazoambo	End	Diels.
APOCYNACEAE	*Cabucala* sp1	Antafaralahy	M/car & Comores	Pichon
APOCYNACEAE	*Cabucala* sp2			
APOCYNACEAE	*Carissa edulis*	Fahavalonkazo	End	Vahl.
APOCYNACEAE	*Carissa* sp	Tambölana be ravina	End	L.
APOCYNACEAE	*Petchia* sp1	Antafaralahy		
APOCYNACEAE	*Petchia* sp2	Andriambavifohy		
APOCYNACEAE	*Plectonia* sp			
AQUIFOLIACEAE	*Ilex mitis*	Hazondrano	End	Radlk.
ARALIACEAE	*Cuphocarpus aculeatus*	Voantsilana	End	Decne. & Planch.
ARALIACEAE	*Cuphocarpus* sp	Voantsilana		Decne. & Planch.
ARALIACEAE	*Polyscias tripinnata*	Voantsilana	End	Harms
ARALIACEAE	*Schefflera* sp1	Voantsilana volombodin-drönga		
ARALIACEAE	*Schefflera* sp2	Voantsilana bory/be ravina		
ARALIACEAE	*Schefflera* sp3	Voantsilandrano		
ARALIACEAE	*Schefflera vantsilana*	Voantsilana	End	(Baker) Bernardi
ARECACEAE	*Chrysalidocarpus decipiens*	Betefaka	End	Beccari
ARECACEAE	*Dypsis brevicaulis*	Tsiriboalavo	End	(Guill.) Beentje & J. Dransf.

FAMILLE	Nom scientifique	Nom vernaculaire	Origine	Auteur
	madagascariensis		Masc.	
CLUSIACEAE	*Mammea bongo*	Vongo be ravina	End	(R. Vig & Humb.) Kostern
CLUSIACEAE	*Mammea* sp1	Vongo fotsy lava ravina	End	
CLUSIACEAE	*Mammea* sp2	Vongo fotsy madini-dravina	End	
CLUSIACEAE	*Ochrocarpos madagascariensis*	Kijy fotsy	End	Choisy
CLUSIACEAE	*Ochrocarpos* sp	Vongo fotsy boribory ravina		Noronha ex Thouars
CLUSIACEAE	*Rheedia madagascariensis*	Kijy	End	(Planch. & Triana) H.Perrier
CLUSIACEAE	*Symphonia fasciculata*	Kijimboalavo lava ravina	End	(Noronha ex Thouars) Vesque
CLUSIACEAE	*Symphonia louvelii*	Kijy be ravina	End	Jum. & H. Perrier
CLUSIACEAE	*Symphonia* sp	Kijy lava ravina		
CLUSIACEAE	*Symphonia tanalensis*	Kijimboalavo	End	Jum & Per.
CLUSIACEAE	*Symphonia verrucosa*	Kijibonaka	End	L.F.
CONNARACEAE	*Cnestis glabra*		Trop	Lam.
CONNARACEAE	*Cnestis polyphylla*	Sefana	Trop	Lamk.
CRASSULACEAE	*Kalanchoe* sp			Adans.
CUNNONIACEAE	*Weinmannia bojeriana*	Lalòna be ravina voloina	End	Tul.
CUNNONIACEAE	*Weinmannia madagascariensis*	Irihitsika	End	D. C.
CUNNONIACEAE	*Weinmannia rutenbergii*	Lalòna	End	Engl.
CUNNONIACEAE	*Weinmannia* sp1	Lalòna be ravina		
CUNNONIACEAE	*Weinmannia* sp2	Lalòna madini-dravina		
CUNNONIACEAE	*Weinmannia* sp3	Lalòna madini-dravina volo		
CUNNONIACEAE	*Weinmannia* sp4	Lalòna malama bory ravina		
CUNNONIACEAE	*Weinmannia* sp5			
CYATHEACEAE	*Cyathea boivinii*	Fanjàna ravimbolo	End	Mett.
CYATHEACEAE	*Cyathea borbonica*	Fanjana		Desv.
CYATHEACEAE	*Cyathea bullata*	Fanjàna vivaona	End	(Baker) Domin
CYATHEACEAE	*Cyathea decrescens*	Faho (Fanjàna tuteur)	End	Mett.
CYATHEACEAE	*Cyathea serratifolia*	Fanjàna tavinalika	End	Baker
CYATHEACEAE	*Cyathea similis*	Fanjàna silokely	End	C. Chr.
CYATHEACEAE	*Cyathea* sp1	Fanjàna		Sm.
CYATHEACEAE	*Cyathea* sp2	Fanjàna voloina		
CYATHEACEAE	*Cyathea* sp3	Fanjàna		
CYATHEACEAE	*Cyathea* sp4	Fanjàna		
CYATHEACEAE	*Cyathea* sp5	Fanjàna		
CYPERACEAE	*Cyperus* sp	Telorirana		L.
CYPERACEAE	*Scleria acriulus*	Tsikisokiso, Vendrana	Afr.	Clarke
DILLENIACEAE	*Dillenia triquetra*	Bararaka	End	(Rottb.) Gilg.
EBENACEAE	*Diospyros gracilipes*	Hazomafana lava ravina	End	Hiern
EBENACEAE	*Diospyros hazomaintii*	Hazomainty	End	H. Perrier
EBENACEAE	*Diospyros myrtiloides*		End	H. Perr.
EBENACEAE	*Diospyros platyrachis*	Maintiampototra	End	
EBENACEAE	*Diospyros* sp			
ELAEOCARPACEAE	*Elaeocarpus* sp	Makarañanala madini-dravina	Trop	L.
ELAEOCARPACEAE	*Elaeocarpus subserratus*	Shaña volombolamena	End	Baker
ELAEOCARPACEAE	*Sloanea rodentha*	Vañana	End	Baker
ERICACEAE	*Agarista polyphylla*	Hazontripa, Angavodiana	End	Baker
ERICACEAE	*Agarista salicifolia*	Hazontripa voloina, be ravina	End	(Comm. ex Lam.) G. Don
ERYTHROXYLACEAE	*Erythroxylum ampullaceum*		End	Baker
ERYTHROXYLACEAE	*Erythroxylum buxifolium*	Menahihy lahy	End	Lam.

FAMILLE	Nom scientifique	Nom vernaculaire	Origine	Auteur
ERYTHROXYLACEAE	*Erythroxylum corymbosum*	Menahihy lahy	End	(Baill) Boivin
ERYTHROXYLACEAE	*Erythroxylum* sp1		End	
ERYTHROXYLACEAE	*Erythroxylum* sp2		Trop	
ERYTHROXYLACEAE	*Erythroxylum sphaerantum*	Menahihy	End	
ERYTHROXYLACEAE	*Polyscias ornifolia*		End	(Baker) Harms
ERYTHROXYLACEAE	*Polyscias* sp1		Trop	J.R. Forst. & G. Forst.
ERYTHROXYLACEAE	*Polyscias* sp2		Trop	
EUPHORBIACEAE	*Antidesma petiolare*	Hoditrovy fotsy	End	(Bak.) J.L.
EUPHORBIACEAE	*Blotia hilderbrandtii*	Maroando	End	(Baill.) Leandri
EUPHORBIACEAE	*Blotia* sp	Fanjava		Leandri
EUPHORBIACEAE	*Bridelia tulasneana*	Arina	End	Baill.
EUPHORBIACEAE	*Croton mongue*	Molanga	End	L.
EUPHORBIACEAE	*Croton* sp1	Masondandy		
EUPHORBIACEAE	*Croton* sp2	Masondandy madini-dravina		
EUPHORBIACEAE	*Croton* sp3			
EUPHORBIACEAE	*Croton* sp4	Masondandy lava ravina		
EUPHORBIACEAE	*Domohinea perrieri*	Hazondomoina	End	Leandri
EUPHORBIACEAE	*Drypetes madagascariensis*	Hazoambonatakay	End	(Lamk.) H. Humb. & J.L.
EUPHORBIACEAE	*Euphorbia pachyclada*	Samata	End	S. Carter
EUPHORBIACEAE	*Euphorbia tetraptera*	Famata	End	Baker
EUPHORBIACEAE	*Macaranga alnifolia*	Makaranandahy	End	Baker
EUPHORBIACEAE	*Macaranga cuspidata*	Makarañana ravavy	End	(Baill.) Boiv.
EUPHORBIACEAE	*Macaranga molanga*	Molanana	End	
EUPHORBIACEAE	*Macaranga obovata*	Shaña be ravina	End	(Baill) Boivin.
EUPHORBIACEAE	*Macaranga perrieri*	Makarañana boribory ravina	End	Leandri
EUPHORBIACEAE	*Macaranga* sp	Makarañana	End	
EUPHORBIACEAE	*Macaranga unifolia*	Makarañana madini-dravina	End	Baill.
EUPHORBIACEAE	*Petalodiscus* sp			
EUPHORBIACEAE	*Phyllanthus mocquerysianus*	Fanavimangidy	End	D. C.
EUPHORBIACEAE	*Phyllanthus* sp	Tsilavidalana madini-dravina		L.
EUPHORBIACEAE	*Suregada* sp	Fanambamangidy		Roxb. ex Rottler
EUPHORBIACEAE	*Uapaca densiflora*	Voapaka be ravina	End	Bak.
EUPHORBIACEAE	*Uapaca thouarsii*	Voapaka madini-dravina	End	H. Baill.
FABACEAE	*Abrus precatorius*		Trop	(L.) W. F. Wight.
FABACEAE	*Acacia latispinosa*		Trop	Desf.
FABACEAE	*Acacia* sp			Mill.
FABACEAE	*Dalbergia baronii*	Voamboana	End	Baker
FABACEAE	*Dalbergia chapelieri*	Voamboana	End	Baill.
FABACEAE	*Dalbergia* sp	Voamboana		L.F.
GENTIANACEAE	*Exacum quinquenervum*			Griseb.
GLEICHENIACEAE	*Sticherus flagellaris*	Rangotohotra	Trop	C. Presl.
HAMAMELIDACEAE	*Dicoryphe obovata*	Avoha	End	
HAMAMELIDACEAE	*Dicoryphe stipulacea*	Voandrozana be ravina	End	J. St.-Hil.
HERNANDIACEAE	*Hazomalania nymphaeifolia*	Hazomalany	End	(Presl) Kubitzki
HYPERICACEAE	*Psorospermum androsaemifolium*	Tambitsiala	End	Baker
HYPERICACEAE	*Psorospermum cerassifolium*	Tambitsy be ravina	End	Baker
HYPERICACEAE	*Psorospermum* sp	Harongandahy	End	
HYPERICACEAE	*Psorospermum trichophyllum*	Arongampanihy	End	Bak.
ICACINACEAE	*Cassinopsis myriocarpa*			
ICACINACEAE	*Cassinopsis* sp			Sond.
LAURACEAE	*Aspidostemon perrieri*	Rotra mena	End	(Danguy) Rohwer

FAMILLE	Nom scientifique	Nom vernaculaire	Origine	Auteur
LAURACEAE	*Beilschmiedia grandiflora*	Voankoro manga	End	Kostern.
LAURACEAE	*Beilschmiedia moratia*	Longondrano	End	Van Der Werff.
LAURACEAE	*Beilschmiedia* sp	Lakaka		Nees
LAURACEAE	*Cryptocaria alseodaphnefolia*	Tavolo be ravina	End	
LAURACEAE	*Cryptocaria anisata*	Tavolopina	End	
LAURACEAE	*Cryptocaria hellicina*	Tavolo sary	End	
LAURACEAE	*Cryptocaria perrieri*	Tavolo lava ravina		
LAURACEAE	*Cryptocaria* sp1	Tavolo mavo ravina		
LAURACEAE	*Cryptocaria* sp2	Tavolopiña madini-dravina		
LAURACEAE	*Cryptocaria* sp3	Tavolo madini-dravina		
LAURACEAE	*Cryptocaria thouvenotii*	Tavolo manitra	End	(Kosterm) Danguy
LAURACEAE	*Cryptocaria* sp4	Hetatra lava ravina		
LAURACEAE	*Ocotea auriculiformis*	Varongy ravi-manga	End	Kosterm.
LAURACEAE	*Ocotea cymosa*	Varongy tain-jaza	End	(Nees) Palacky
LAURACEAE	*Ocotea laevis*	Varongy malailay	End	Kosterm
LAURACEAE	*Ocotea madagascariensis*	Varongy fotsy	End	(Meisn.) Palacky
LAURACEAE	*Ocotea nervosa*		End	Kosterm.
LAURACEAE	*Ocotea* sp	Varongy		
LAURACEAE	*Potamea obovata*	Tavaratra be ravina	End	Kosterm
LAURACEAE	*Ravensara acuminata*	Tavolopiña lava ravina	End	Baill.
LAURACEAE	*Ravensara aromatica*	Tavolo hazomanitra, Havozo	End	Sonnerat
LAURACEAE	*Ravensara perareolata*	Tavolo mena laingo	End	Kosterm.
LECYTHIDACEAE	*Foetidia asymetrica*	Nanto	End	H.Perrier
LILIACEAE	*Asparagus simulans*	Tsatsangotrala	Trop	Baker
LILIACEAE	*Asparagus* sp	Avivoravina		L.
LILIACEAE	*Dianella ensifolia*	Voamasonomby	Asie Trop	(Juss) Lam.
LILIACEAE	*Dracaena reflexa* var.1	Hasina	Trop	Lam.
LILIACEAE	*Dracaena reflexa* var.2	Hasina madini-dravina	Trop	Lam.
LOGANIACEAE	*Anthocleista longifolia*	Lendemy lava ravina	End	(Lamarck) Boiteau
LOGANIACEAE	*Anthocleista madagascariensis*	Lendemilahy	End	(R.Br.) Afzel.
LOGANIACEAE	*Nuxia capitata*	Valanirana	End	Baker
LORANTHACEAE	*Bakerella clavata*	Dongavelona	End	Desrous
MALVACEAE	*Dombeya biumbellata*	Hafopotsy	End	Baker
MALVACEAE	*Dombeya indica*	Hafotra		
MALVACEAE	*Dombeya lucida*	Hafobalo ladia madini-dravina	End	Baill.
MALVACEAE	*Dombeya* sp1	Tsifantabahiny	Afr & Mcar	
MALVACEAE	*Dombeya* sp2	Hafobalo lava ravina		
MALVACEAE	*Dombeya* sp3	Hafobalo be ravina		
MALVACEAE	*Dombeya* sp4	Hafobalo tena madini-dravina		
MALVACEAE	*Dombeya spectabilis*	Tsifantabahiny, Manafôza		Cordem.
MALVACEAE	*Grewia apetala*		End	Juss.
MALVACEAE	*Grewia brideliifolia*		End	Baill.
MALVACEAE	*Grewia rotunda*		End	C.Y. Wu ex Hung T. Chang
MALVACEAE	*Grewia* sp			
MALVACEAE	*Helmiopsis* sp			H. Perrier
MALVACEAE	*Hibiscus* sp			L.
MALVACEAE	*Hildegardia perrieri*	Vinòna	End	Hochr. J. Ar.
MALVACEAE	*Nesogordonia* sp		End	Baill.
MALVACEAE	*Rulingia madagascariensis*	Hafodambo	End	Baker
MELANOPHYLLACEAE	*Melanophylla* sp1		End	Baker
MELANOPHYLLACEAE	*Melanophylla* sp2	Hazomporetika manga laingo	End	
MELANOPHYLLACEAE	*Melanophylla* sp3	Malemiravina be ravina	End	Baker

FAMILLE	Nom scientifique	Nom vernaculaire	Origine	Auteur
MELASTOMACEAE	*Clidemia hirta*	Mazambody	Cosm Trop	(L.) D. Don
MELASTOMATACEAE	*Dichaetantera cordifolia*	Belavenona	End	Baker
MELASTOMATACEAE	*Dichaetantera rosea*	Belavenona madini-dravina	End	Cogn.
MELASTOMATACEAE	*Dichaetanthera lutescens*	Belavenona	End	H. Perr
MELASTOMATACEAE	*Medinilla parvifolia*	Takasina	End	Baker
MELASTOMATACEAE	*Medinilla* sp			Gaudich. ex DC.
MELASTOMATACEAE	*Memecylon clavistaminum*	Tsimahamasatsokina	Trop	Jacq.-Fél.
MELASTOMATACEAE	*Memecylon longipetalum*	Tsimahamasatsokina lava ravina	End	H. Perrier
MELASTOMATACEAE	*Memecylon* sp1	Hoditrovy be ravina		
MELASTOMATACEAE	*Memecylon* sp2	Tsimahamasatsokina be ravina		
MONIMIACEAE	*Ephippiandra madagascariensis*	Amborarano	End	(Danguy) Lorence
MONIMIACEAE	*Tambourissa ampifolia*	Ambora boribory ravina	End	Boj.
MONIMIACEAE	*Tambourissa madagascariensis*	Ambora	End	Cavaco
MONIMIACEAE	*Tambourissa purpurea*	Ambora madini-dravina	End	(Tul.) A. DC
MONIMIACEAE	*Tambourissa* sp	Ambora minifin-tsofa		
MONIMIACEAE	*Tambourissa thouvenotii*	Ambora be ravina	End	(Danguy) Cavaco
MONIMIACEAE	*Tambourissa trichophylla*	Ambora madini-dravina	End	Baker
MONIMIACEAE	*Tambourissa religiosa*	Amboralahy madini-dravina	End	(Tul.) A. DC.
MORACEAE	*Alleanthus greveanus*	Dipaty/Manasavelona	End	
MORACEAE	*Ampalis* sp			Bojer ex Bureau
MORACEAE	*Bosqueia* sp	Dipaty		Thouars ex Baill.
MORACEAE	*Ficus pachyclada*	Ramiringitra lava ravina	End	Baker
MORACEAE	*Ficus soroceoides*	Ambavy	End	Baker
MORACEAE	*Ficus* sp1	Hafotra ramiringitra		L.
MORACEAE	*Ficus* sp2	Amontana		
MORACEAE	*Ficus torrentium*	Ramiringitra fotsy	End	H.Perrier
MORACEAE	*Morus alba*	Voaroy	End	L.
MORACEAE	*Pachytrophe dimepate*		End	Bureau
MORACEAE	*Streblus obovata*	Dipaty		
MORACEAE	*Trilepisium* sp	Ramiringitra be ravina		
MYRSINACEAE	*Maesa lanceolata*	Rabedoda		G. Don
MYRSINACEAE	*Monoporus* sp			A. DC.
MYRSINACEAE	*Oncostemum elephantipes*	Ramitsiaka madini-dravina	End	H. Perr.
MYRSINACEAE	*Oncostemum grandifolium*	Maimboloha	End	
MYRSINACEAE	*Oncostemum lauriflorum*	Ramitsiaka	End	Bojer
MYRSINACEAE	*Oncostemum madagascariensis*		End	
MYRSINACEAE	*Oncostemum palmiforme*	Masompozalahy	End	H. Perr.
MYRSINACEAE	*Oncostemum platycladum*	Ramitsiaka lava ravina madinika	End	Backer
MYRSINACEAE	*Oncostemum* sp1		End	A. Juss.
MYRSINACEAE	*Oncostemum* sp2			
MYRSINACEAE	*Rafanea* sp			
MYRTACEAE	*Eugenia acumenae*	Rotra mena lava ravina		
MYRTACEAE	*Eugenia bernieri*	Rotra fotsy madini-dravina	End	Baill.
MYRTACEAE	*Eugenia emirnense*	Robary	End	
MYRTACEAE	*Eugenia gavoala*	Gavoala	End	
MYRTACEAE	*Eugenia grossepunetata*			
MYRTACEAE	*Eugenia hazompasika*	Hazompasina (Hazompasika)	End	H. Perr
MYRTACEAE	*Eugenia lokohensis*	Rotra	End	H. Perr
MYRTACEAE	*Eugenia* sp1	Rotra be ravina		L.
MYRTACEAE	*Eugenia* sp2	Rotra		

FAMILLE	Nom scientifique	Nom vernaculaire	Origine	Auteur
RUBIACEAE	*Coffea* sp1	Kafeala		L.
RUBIACEAE	*Coffea* sp2			
RUBIACEAE	*Enterospermum coptosperma*	Pitsikahitra mena	End	
RUBIACEAE	*Enterospermum* sp			Hiern.
RUBIACEAE	*Gaertnera macrostipula*	Bararaka	End	Baker
RUBIACEAE	*Gaertnera macrostipulata*	Amalomanta, Hazontoloho, Karakarantoloho, Tsikafekafe	End	Baker
RUBIACEAE	*Gaertnera obovata var sphaerocarpa*		End	Baker
RUBIACEAE	*Gaertnera rubia*	Tsikafokafe	End	
RUBIACEAE	*Gaertnera* sp1	Tsikafekafe be ravina	Asie Trop	
RUBIACEAE	*Gaertnera* sp2			
RUBIACEAE	*Gaertnera* sp3	Tsikafekafe voloina		
RUBIACEAE	*Gallenia sclerophylla*	Pitsikahitra		Dubard & Dop
RUBIACEAE	*Hyperacanthus thouvenotii*	Tölañana	End	
RUBIACEAE	*Ixora* sp			L.
RUBIACEAE	*Mapouria macrochlamys*	Bararaka		Bremek.
RUBIACEAE	*Mapouria* sp	Tsikafekafe orange be ravina	Trop	Aubl.
RUBIACEAE	*Mussaenda* sp1			L.
RUBIACEAE	*Mussaenda* sp2	Malemiravina voloina		
RUBIACEAE	*Pauridiantha paucinervis* ssp *lyallii*	Tsiandrövana	End	(Baker) Verdc.
RUBIACEAE	*Pauridiantha palide-fusca*		End	
RUBIACEAE	*Pauridiantha pauciflora*		End	
RUBIACEAE	*Psychotria parkeri*	Maroitsaka/Molopangady		Bremek
RUBIACEAE	*Psychotria* sp1	Amalomanta be ravina	End	
RUBIACEAE	*Psychotria* sp2	Maroivañy madini-dravina		
RUBIACEAE	*Psychotria* sp3	Pitsikahibato		
RUBIACEAE	*Sabicea diversifolia*	Hazomporetika		Pers.
RUBIACEAE	*Saldinia littoralis*	Malemiravina madini-dravina	End	Bremek.
RUBIACEAE	*Saldinia miritoides*	Maroampototra	End	Bremek.
RUBIACEAE	*Saldinia myrtiloides*			Brem.
RUBIACEAE	*Saldinia* sp			A. Rich. ex DC.
RUBIACEAE	*Schismatoclada psychotrioides*	Amalomanta manga	End	Baker
RUBIACEAE	*Tricalysia albicaulis*	Tsotsoraka	End	
RUBIACEAE	*Tricalysia analamazaotrensis*	Tsikafekafe fotsy hoditra	End	(Randriamb. & De Block) Homolle
RUTACEAE	*Evodia balankazo*	Fatraina	End	P.D.Bath.
RUTACEAE	*Vepris aralioides*	Ampodivato be ravina	End	H. Perrier
RUTACEAE	*Vepris fitoravina*	Ampodisasatra	End	H. Perrier
RUTACEAE	*Vepris macrophylla*	Ampody	End	(Baker) I. Verd.
RUTACEAE	*Vepris pilosa*	Ampody	End	(Baker) I. Verd.
RUTACEAE	*Vepris* sp	Ampodisasatra	End	Comm. ex A. Juss.
RUTACEAE	*Xanthoxylum tsianihimposa*	Tsianihimpösa	End	
SALICACEAE	*Aphloia theaeformis*	Voafontsy	End	Benn.
SALICACEAE	*Aphloia theaeformis* var *minima*	Fandramananala	End	(Baker) H. Perrier
SALICACEAE	*Aplaylus trichodesmus*		End	
SALICACEAE	*Casearia nigrescens*	Ropadirana	End	Jacq.
SALICACEAE	*Homalium albiflorum*	Hazoambo lava ravina	End	H. Hoffm
SALICACEAE	*Homalium axillare*		End	(Lam.) Benth.
SALICACEAE	*Homalium* sp1		End	
SALICACEAE	*Homalium* sp2	Hazombato		
SALICACEAE	*Homalium* sp3	Valanirandrano		
SALICACEAE	*Ludia* sp	Hazombarorana be ravina		
SALICACEAE	*Scolopia* sp	Ambalasira		

FAMILLE	Nom scientifique	Nom vernaculaire	Origine	Auteur
MYRTACEAE	*Eugenia vacciniaefolia*	Rotra fotsy be ravina		
MYRTACEAE	*Syzygium emirnense*	[illegible]	End	[illegible]
NEPHROLEPIDACEAE	*Nephrolepis* sp	[illegible]		Schott
OCHNACEAE	*Campylospermum* sp			Tiegh.
OCHNACEAE	*Ouratea dependens*	[illegible]	End	(DC) H. Perrier
OLEACEAE	*Noronhia oblongifolia*	[illegible]	End	H. Perrier
OLEACEAE	*Noronhia* sp1	[illegible]		Stadtm. ex Thouars
OLEACEAE	*Noronhia* sp2	[illegible]		
OLEACEAE	*Noronhia verticillata*	[illegible]	End	H. Perr.
OLEACEAE	*Olea* sp			
OLEACEAE	[illegible]	[illegible]	End	[illegible]
ORCHIDACEAE	*Aerangis* sp			[illegible]
ORCHIDACEAE	*Bulbophyllum* sp			Thouars
ORCHIDACEAE	[illegible]			
ORCHIDACEAE	*Liparis* sp			Rich.
OXALIDACEAE	*Biophytum sensitivum*		Trop	(L.) DC.
PANDANACEAE	*Pandanus* [illegible]	Vakoana	End	
PANDANACEAE	*Pandanus madagascariensis*	[illegible]	End	Balf.f.
PANDANACEAE	*Pandanus pulcher*	[illegible]	End	Martelli
PANDANACEAE	*Pandanus vandamii*	[illegible]	End	Martelli & Pic. Serm.
PHYSENACEAE	*Physena madagascariensis*	[illegible]	End	Thouars ex Tul.
PIPERACEAE	*Piper nigrum*	[illegible]	Trop	L.
PITTOSPORACEAE	*Pittosporum ochrosiaefolium*	[illegible] madini-dravina	Trop. & S.A.S	Bojer
PITTOSPORACEAE	*Pittosporum* sp	Hazombary		Banks ex Gaertn.
POACEAE	[illegible]	[illegible]		[illegible]
POACEAE	[illegible]	[illegible]	Trop	[illegible]
POACEAE	[illegible]	[illegible]	End	
POACEAE	*Setaria* [illegible]	[illegible]	Trop	Stapf & C.E.Hubb.
POACEAE	[illegible]	[illegible]		[illegible]
PODOCARPACEAE	[illegible]	Hetatra	End	Baker
POLYPODIACEAE	[illegible]			[illegible]
POLYPODIACEAE	[illegible]			Link
POLYPODIACEAE	[illegible]		End	Schott ex J. Sm.
POLYPODIACEAE	*Polypodium* sp	[illegible]		L.
PROTEACEAE	*Dilobeia thouarsii*	Vivaona	End	Roem. & Schult.
RENONCULACEAE	*Clematis* sp			L.
RHIZOPHORACEAE	*Cassipourea* sp	Ambalasira		Aubl.
ROSACEAE	*Rubus moluccanus*	Takoaka	Trop	L.
RUBIACEAE	*Antirhea* sp			Comm. ex Juss.
RUBIACEAE	*Bremeria perrieri*	Pitsikahitra be ravina	End	Lam.
RUBIACEAE	*Bremeria* sp1	Pitsikahitra lava ravina		Razafim. & Alejandro
RUBIACEAE	*Bremeria* sp2	Pitsikahitra madini-dravina		
RUBIACEAE	*Bremeria* sp3			
RUBIACEAE	*Breonia* [illegible]	Vandrika, Tölañana be ravina	End	A. Rich.
RUBIACEAE	*Canthium blepharodon*	[illegible]	End	(Cavaco) [illegible]
RUBIACEAE	*Canthium* sp	Pitsikahitra		Lam.
RUBIACEAE	*Chassalia bojeri*	Amalomanta madini-dravina	End	[illegible]
RUBIACEAE	*Chassalia ternifolia*	Marefolena	End	(Baker) Bremek.
RUBIACEAE	*Coffea mangoroensis*	Pitsikahitra bory ravina	End	Portères